NORTHEASTERN FOREST EXPERIMENT STATION
Division of Watershed Management Research

Semiannual Report April 1965

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GENERAL

During the past 6 months we had two sessions with staff and watershed people from Region 7, a Workshop at Hubbard Brook October 22-24 followed by a Seminar in Upper Darby January 14-15. The Workshop served to bring us up to date on current research and problems; the Seminar dealt with matters of program and coordination. As meetings go, they were more fruitful than most; we better understand each other and mutual problems and goals.

The International Symposium on Forest Hydrology came to life with an injection of funds by the NSF. It's a two-week session, August 29 - September 10 that should advance this somewhat-confusing art of ours to a higher level of intelligibility. Proceedings will be published.

Did you see this?

> ...the title, "Watershed Management", is an American term which has unfortunately already been almost universally accepted by the underdeveloped countries which are being helped to make plans for soil erosion control and water conservation. In standard English the watershed is a line, not an area, and is the ridge line between two adjacent catchments, the word catchment being the correct name for the area drained by a stream. For the sake of peace we have to accept yet another American inaccuracy to make ourselves understood!
>
> (Scottish Forestry 19: 2, 1965.)

FERNOW EXPERIMENTAL FOREST

The Fernow Five

The second cut on one of the original Fernow Five watersheds was made in 1963-64. This was on the Intensive Selction Watershed, No. 3, which has a 5-year cutting cycle. The cut was light, only 1,200 bd. ft. or 9.2 sq. ft. of basal area per acre, as after the first cut, changes in discharges were generally not significant. A small but significant increase of 1,100 gallons per acre occurred in October 1964; it is of interest to note that significant increases also occurred in October 1959 and October 1960 after the first cut.

Significant increases in growing-season discharge occurred on the Commercial Clearcut Watershed (No. 1) in 1957, 1958, 1959, 1960 and 1962; the increase in 1961 was not significant. Study of precipitation data sheds some light on the 1961 situation; variation in precipitation was not considered in the original analyses. During the 12-year period of record, growing-season precipitation of No. 1 averaged 102 percent of the Control. In 1961, it was only 97 percent of the Control; this was the only post-treatment year when it was less than the Control. This apparently explains why the 1961 increase was not significant and the 1962 increase was. Nineteen-sixty-two, the fifth season after completion of treatment, was probably the last year for significant increases. In the 1963 and 1964 growing seasons, computations indicated very little difference from the pretreatment relationships; slightly negative changes were indicated.

We were pleased to be able to supply Fernow Five records to Charles Troendle, one of Art Eschner's students at Syracuse. He is analyzing to see the effect of watershed treatment on the minimum 1/4 and 1/2 flow intervals and the maximum 1 and 5 percent flow intervals. We will be interested to see the results of this study.

Half-cut watersheds

We finally completed the first-round treatment of Watershed Upper 7 where we are aiming at complete removal of vegetation. Treatment consisted of a pre-logging basal spray, logging and small products operation with silvicide treatment of sapwood, a felling of residuals, a mistblowing application early in the growing season and a second spot-application with mistblower in August; all herbicide used was the octyl-ester of 2,4,5-T. We estimate that this treatment (not including sawlog and small products operations, which paid for themselves) cost us just over $50 per acre. The results were good, though not perfect.

Watershed Lower 6 has received the same treatment except for mistblowing; this will be undertaken in the coming growing season (along with repeat application on Upper 7). In future treatments, the presence of grass, which is not susceptible to 2,4,5-T, will have to be dealt with.

Preliminary analyses indcate that on Watershed 7, in the 1964 growing season, the increase was slightly over 7 area-inches (or almost 200,000 gallons per acre) on the treated area. During the season, cutting on No.6 was not complete and the increase in flow was much less.

Help!

Our Commercial Clearcut Watershed was cutover in 1957-58. In 1957 (before cutting) and in 1961 and 1964, we took measurements of the depth of the H + A_1 layers. The mean values for the clearcutting look interesting: 2.39, 2.04, and 1.65 inches in 1957, 1961 and 1964, respectively. It appears that treatment had a real effect. But the Control showed 2.40, 2.02 and 1.33 inches in the same years! Our simple method of cutting a hole and optically determining the proper depth is apparently not working. We tried hard to avoid personal bias; in 1964 we got back on detail the man who did the job in 1961. Suggestions will be welcomed on a better approach to determining changes in humus as a result of clearcutting.

Odd jobs

We now have the opportunity to purchase solar-radiation, soil-moisture, and some other equipment that we have been wanting for many moons. The necessity of making decisions that we will have to live with a long time means that we approach this task with mixed emotions.

A start has been made on assembling background material for the new problem analyses. We expect to prepare two of these: (1) Flood flows from rainfall and from combined rainfall and snowmelt. (2) Low streamflow during summer and fall months.

--Ken Reinhart
Jim Hornbeck

HUBBARD BROOK EXPERIMENTAL FOREST

Automatic data processing

Streamflow records from seven watersheds are now being processed by computer. This is made possible through our cooperative agreement with Dartmouth College. A.G.E.325 computer is available to us. Time and head values are transcribed manually from the charts to forms and then are punched onto cards. Computer outputs include flow between time intervals and daily and monthly totals. A subroutine for flow frequency classification will soon be included. We anticipate the ADP system will allow us to keep streamflow records current to within one month following chart removal.

Winterized stream-gaging stations

For three years we have used bottled-gas heaters to reduce freezing in gage-house wells. This winter, mouse-chewed plastic tubing and unexplainably extinguished pilot lights have caused several explosions of accumulated gas when the re-lighted burner was returned to the well. We have replaced the plastic tubing with copper, increased ventilation, and purchased devices which automatically shut off the gas flow when the burner is extinguished.

Snowmelt runoff

Initial attempts at predicting snowmelt runoff have led to the equation

$$Y = 0.149 + 0.009\ (T - 32)^2$$

in which T is the maximum daily temperature in ^{o}F and Y is daily snowmelt in area inches. The exponential decay equation has been used to distribute the daily contribution from melt (Y) and from rain into a recession over several successive days. Decay constants of 0.03 in./hr. for snowmelt and 0.05 in./hr for rain gave the best fit to observed hydrographs. The different values required indicate that rain water reaches the stream faster than snowmelt.

Wind profiles

Measurements of wind profiles over forest stands suitable for determining the surface roughness and zero-plane displacement are practically non-existent. We are beginning a study to measure profiles over pine plantations and northern hardwood forest. We would appreciate hearing of any prior measurements of this type that have been made.

Water budget computer program

A study is planned to write a computer program to predict daily streamflow and soil moisture from known daily precipitation and from both Thornthwaite and solar radiation estimates of potential evapotranspiration. A number of different techniques will be tried to see which agree best with observed streamflow.

Winter streamflow

Sustained winter flows of 0.007 to 0.020 area inches per day throughout the winter can be explained by conduction of heat from within the soil to the bottom of the snowpack causing snowmelt. Measured soil temperature profiles and estimated soil thermal conductivities lead to estimates of this groundmelt which agree well with the measured streamflow.

Open House

The tenth anniversary of the Hubbard Brook Experimental Forest was celebrated last October with an Open House. Director Ralph Marquis led the ceremonies with talks from Station personnel and Clark Holscher from the Washington Office who explained the purpose of the Hubbard Brook program and discussed the past, present, and anticipated future research in Watershed Management. The Honorable Thomas J. McIntyre, United States Senator from New Hampshire gave the address to: Officials from the Forest Service, Soil Conservation Service, State, County, and nearby towns; representatives from Dartmouth College and the University of New Hampshire, and the general public. Exhibits of research work underway and guided tours of the new headquarters building and the Experimental Forest complemented the festivities.

--Bob Pierce
George Hart
Tony Federer

NEW LISBON

We are pleased to report the results of preliminary analyses on the calibration of the cooperative watersheds at Baltimore and at Newark. Both of these calibration analyses turned out satisfactorily.

Baltimore Watersheds

Two of the three experimental subwatersheds near the Liberty Reservoir have records dating back to August 1958, but records for the third did not begin until November 1959. Thus, the data for Watershed No. 3 are rather meager for calibration. Furthermore, the yield of this watershed has been so low that a leaky aquifer was suspected, and the possibility of calibration was considered doubtful. To our surprise, the correlation of this watershed with the Control Watershed (No. 2) is about as good as that of Watershed No. 1 which was obviously well-correlated with the Control. And the low yield could well be caused by the difference in cover. The cover on No. 3 is a mature hardwood forest, in contrast to young pine plantations covering the other two watersheds. The water-loss value (P-RO, and presumed to be evapotranspiration) is almost exactly the same as the estimated evapotranspiration on the Control Watershed at the Fernow Experimental Forest in West Virginia, a watershed with comparable cover.

The following tabulation presents the pertinent data and results of the analysis:

Watershed	Period	Calibration	Mean precip.	Mean runoff calibration period	Corr. coeff. r	Std. err. est. $s_{y.x}$	Increase required to show sign. at 5% level
			Inches	Inches		Inches	Inches
#1	Annual	Six Oct 1 years	36.70	10.20	0.947**	1.09	2.52
#3	Annual	Four Oct 1 years	36.07	4.16	0.985*	0.48	1.56
#1	Growing season	Six years	17.28	3.80	0.969**	0.48	1.10
#3	Growing season	Five years	16.98	1.82	0.963**	0.30	0.67
#1	Dormant season	Six years	19.28	6.30	0.950**	0.54	1.26
#3	Dormant season	Five years	20.94	2.22	0.914*	0.56	1.44

* Correlation significant at 5-percent level.
** Correlation significant at 1-percent level.

Howard Lull and Irv Reigner met with Lou Ningard and Ron Singer, respectively the Superintendent and Forester of the Baltimore watersheds, to develop plans for the future conduct of the experiment. It was decided to begin treatment on Watershed No. 1 this coming October with the removal of the riparian vegetation. Subsequent treatments on this watershed will entail thinning the pine plantation.

Because Watershed No. 3 has recorded only four October 1 years, treatment will be held off until October 1966, at which time a partial

cutting will be made, probably on a diameter-limit basis. Eventually, all the forest cover will be removed from this subwatershed, to test the extreme of watershed treatment. Logging will be done as carefully as possible, to maintain water quality and the present character of the land surface.

Newark Watersheds

The second of the two analyses was even more successful than at the Baltimore watersheds and treatment will be initiated in May of this year.

The three subwatersheds on the Pequannock Watershed owned by the City of Newark, New Jersey, have been in calibration since May 1959. While only slightly larger than the Baltimore watersheds, the differences in precipitation, climate, and water-holding capacity make very interesting comparisons between the two experiments.

The following table shows that the standard errors of estimate ($s_{y.x}$) are in the same order as at Baltimore, but that the correlation coefficients are much higher. This is due to the much higher yields from the Newark watersheds with consequently greater variances in annual and seasonal yields. The higher yields are due, of course, to greater precipitation and cooler climate.

Water-shed	Period	Cali-bra-tion	Mean precip.	Mean runoff cali-bra-tion period	Corr. coeff. r	Std. err. est. $s_{y.x}$	Increase required to show sign. at 5% level
			Inches	Inches		Inches	Inches
#1	Annual	Five May 1 years	47.06	23.05	0.993***	0.91	2.34
#3	Annual	Five May 1 years	47.15	21.64	0.996***	0.67	1.73
#1	Growing season	Six years	21.82	4.03	0.999***	0.16	0.37
#3	Growing season	Six years	21.91	4.00	0.995***	0.43	0.98
#1	Dormant season	Five years	23.56	18.53	0.984**	0.79	2.03
#3	Dormant season	Five years	23.53	17.16	0.998***	0.32	0.82

** Significant at 1-percent level.
*** Significant at 0.1-percent level.

Only 20 percent of the mean annual yield is delivered during the growing season, as against 40 percent at Baltimore, indicating that the steeper and rockier slopes on the Pequannock Watershed have less water-holding capacity than the rolling Piedmont lands near Baltimore.

Dilldown Watershed

Conversion of this scrub-oak covered watershed in the Poconos has not been completed because of our inability to plant very rocky areas. Research in direct seeding has progressed to the point where we believe such areas can be revegetated by a chemical treatment to kill the existing vegetation followed by direct seeding. A pilot study will be installed this summer.

To determine how much area is left to be revegetated, Si Little, Irv Reigner, and Jack Denniston made a quick survey of the area last October. The area needing treatment was found to be much smaller than

originally designated; only about 130 acres need treatment. Over 500 acres originally designated as needing revegetation have undergone type change. The hot, long-burning fire in July and August 1955 killed the existing vegetation, which is ordinarily fireproof and sprouts vigorously. Aspen has since taken over these areas and promises to form a suitable stand. Is there a lesson to be learned here?

--Irv Reigner

SYRACUSE

Adirondack study

Copies of Art Eschner's Ph.D dissertation Forest protection and streamflow from an Adirondack Watershed (State University College of Forestry at Syracuse University, 209 pp., 1965) have been sent to all Stations.

Surface geometry

This think paper on disposition of intercepted snow, by Satterlund and Eschner, will soon be available as a Station Research Paper. On the basis of equations for turbulent heat and vapor transfer, and reasoned application of knowledge about intercepted snow, a great difference in the energy and vapor balance between an intercepted "snowfield" and one on level ground is predicted. The differences, resulting from the complex surface geometry of a closed conifer forest, are sufficient to account for considerably greater losses from intercepted snow.

Streamflow analysis

The flow-interval technique of Satterlund and Eschner is being applied to streamflow data from five of the watersheds on the Fernow Experimental Forest by graduate student Charles Troendle.

Based on the work completed, it appears that most intervals will prove to have changed significantly since treatment. The longest one percent and five percent intervals in summer seem to have been affected the most (shortened), while some changes may be present in the shortest one-quarter and one-half flow intervals (lengthened). From the results of the analysis, it may also be inferred that following treatment, the longest one percent and five percent intervals started later in the year, as well as being shortened.

Reflectivity investigation

The major portion of the equipment for the reflectivity investigation of a red pine plantation has arrived. Two Moll-Grozinski solarimeters are to be passed along a tramway above the plantation. Towers supporting the tramway are of the R.C.A. 12-inch triangular type. Each 10-foot section weighs around 35 pounds, three men can erect a 70-foot tower in about 4 hours.

--Ray Leonard

PUBLICATIONS

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The importance of dew in watershed-management research. James W. Hornbeck. U.S. Forest Serv. Res. Note 24, 5 pp., illus.

Ecological and silvicultural aspects. Howard W. Lull. In Handbook of applied hydrology: 6-1 to 6-30, illus. McGraw-Hill Book Co., New York.

Frequency of streamflow measurements required to determine forest treatment effects. Kenneth G. Reinhart. U.S. Forest Serv. Res. Note NE-23, 7 pp.

Streamflow characteristics of physiographic units in the Northeast. William E. Sopper and Howard W. Lull. Water Resources Research 1: 115-124, illus.

Herbicidal treatment of watersheds to increase water yield. K. G. Reinhart. Proc. Northeastern Weed Control Conf. 19: 546-551.

Manuscripts submitted:

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Sensors for measuring light available for photosynthesis. C. A. Federer and C. B. Tanner.

Artificial light for plant growth. C. A. Federer and C. B. Tanner.

A simple integrating pyranometer for measuring daily solar radiation. C. A. Federer and C. B. Tanner.

Watershed management research in the Northeast. R. S. Pierce.

The representativeness of small forested experimental watersheds in the Northeastern United States. William E. Sopper and Howard W. Lull.

Thirteen million pounds. Kenneth G. Reinhart.

Land use, snow melt and streamflow in Central New York. Donald R. Satterlund and Arthur R. Eschner.